

***CTE Standards Unpacking  
Alternative Energy Systems***

**Course:** Alternative Energy Systems

**Course Description:** This course serves as an introductory course in alternative energy. This is a survey of wind, biomass, solar, geothermal, and other non-traditional energy sources.

**Career Cluster:** STEM

**Prerequisites:** None

**Program of Study Application:** This is a STEM Pathway Course for the Energy Pathway, preceded by a Foundational Course(s) and a Cluster Course(s).

<b>INDICATOR #AES 1: Understand the historical development of alternative energy systems</b>		
<b>SUB-INDICATOR 1.1 (Webb Level: 3 Strategic Thinking):</b> Understand the historical background of alternative energy generation		
<b>SUB-INDICATOR 1.2 (Webb Level: 3 Strategic Thinking):</b> Analyze the role of society in the use of energy generation methods		
<b>SUB-INDICATOR 1.3 (Webb Level: 4 Extended Thinking):</b> Analyze the cultural, socioeconomic and political effects of alternative energy technologies		
<b>SUB-INDICATOR 1.4 (Webb Level: 3 Strategic Thinking):</b> Understand the environmental impact of energy production and consumption.		
<b>Knowledge (Factual):</b> Understand and define terminologies such as renewable, alternative and non-renewable energy  Energy generation system and their growth over the period of time  Energy production and associated cost, including environmental impact	<b>Understand (Conceptual):</b>  Different types of alternative energy exist  Demand for alternative energy is ever increasing, as scientific evidence indicates a need for cleaner energy sources.  Use and production of alternative energy sources depends on technological advancement  Energy source (type) affects the socio-economic, political and cultural aspect of the	<b>Skills (Application):</b>  Be able to identify and differentiate various types of alternative energy sources  Know the evolution of energy sources with changing times  Know that alternative energy sources can impact the socio-cultural and political status of the nation  Describe the environmental impact of

	nation	current energy sources on the environment (climate change, ecosystems, biodiversity, pollution)
<b>Benchmarks</b> <i>Students will be assessed on their ability to:</i> <ul style="list-style-type: none"> <li>• Define and identify the different terminologies of the alternative energy sources</li> <li>• Understand the different types of alternative energy system</li> <li>• Know alternative energy system can influence the economic growth of the nation</li> <li>• Evaluate the cause and effect relationships between energy consumption and energy transfer on the planet</li> <li>• Describe the environmental impact of the use of various energy sources.</li> </ul>		
<b>Academic Connections</b>		
<b>ELA Literacy and/or Math Standard (if applicable, Science and/or Social Studies Standard):</b>  <b>Social Studies</b> 9-12.G.6.2 Evaluate how different cultures identify and utilize natural resources.  9-12.G.6.3 - Explain the ways technology expands the human capacity to use and modify the physical environment.  9-12.E.5.6 Analyze how the global economy has changed the interaction of buyers and sellers in the U.S. economy.	<b>Sample Performance Task Aligned to the Academic Standard(s):</b>  <b>Social Studies</b> Students could write a report or do a presentation about the history of energy production in the US and how alternative energy sources have emerged. Students might jigsaw the activity, focusing on different countries or global relationships between the US and other nations. Their work should reflect the following: the relationship between economics and energy production, the dynamics of supply and demand in relation to alternative energy development and affordability, the relationship between science, politics, policy and the economy, and social cultural aspects.  Students might focus on socio-economic issues related to industry and energy production as well.	

<p><b>English Language Arts</b> 9-10.RI.1 Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.</p> <p>11-12.W.1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. a. Introduce precise,</p> <p>11-12.W.2. Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.</p> <p>11-12.W.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and over-reliance on any one source and following a standard format for citations.</p> <p><b>Science and Engineering Practices</b> • Asking Questions and Defining</p>	<p>Create an infographic that follows the lifecycle of a product or type of energy identifying various factors including economic, social, political, environmental and cultural.</p> <p><b>English Language Arts</b> Write and discuss a review of abstracts from peer reviewed sources regarding climate change and energy production.</p> <p>Design a model for some aspect of climate change or energy transfer on Earth. Write a summary explaining the model.</p> <p>Carry out an investigation of a variable that effects climate and write a report about findings. Write a paper summarizing the major issues in the climate change debate, identifying the stakeholders and the costs/benefits of several solutions, justifying one particular solution with evidence.</p> <p>Conduct a mock hearing regarding the implementation of alternative energy. Invite government officials to be adjudicators.</p> <p><b>Science and Engineering Practices/Science</b></p>
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<ul style="list-style-type: none"> <li>• Problems Developing and Using Models</li> <li>• Planning and Carrying out Investigations</li> <li>• Analyzing and Interpreting Data</li> <li>• Using Mathematical and Computational Thinking</li> <li>• Constructing Explanations and Designing Solutions</li> <li>• Obtaining, Evaluating, and Communicating Information</li> <li>• Engaging in Argument from Evidence</li> </ul> <p><b>Science</b> HS-ESS2-3 Use a model to describe how variations in the flow of energy into and out of Earth’s systems result in changes in climate. (SEP: 2; DCI: ESS2.A, ESS2.B, PS4.A; CCC: Energy/Matter, Technology)</p> <p>HS-ESS3-2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.* (SEP: 7; DCI: ESS3.A, ETS1.B; CCC: Technology)</p> <p>HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* (SEP: 6; DCI: ESS3.C, ETS1.B; CCC: Stability/Change, Technology)</p> <p><b>Oceti Sakowin</b> ESSENTIAL UNDERSTANDING 2 There is variety and resiliency among individual Tribal people as identity is developed, defined and redefined by entities, organization and people. A continuum of tribal identity, unique to each individual, ranges from assimilated to traditional lifestyle. There is no “generic American</p>	<p>Design and carry out an investigation of a variable that impacts climate.</p> <p>Create a model that demonstrates an aspect of climate change.</p> <p>Analyze historic data for temperature and precipitation for South Dakota.</p> <p>Use models such as those developed by NASA to interpret changes in climate on the planet. Summarize and communicate observations.</p> <p>Use Socratic seminar to discuss an article about climate change or alternative energy.</p> <p><b>Oceti Sakowin</b> Relate traditional tribal values and practices to topics such as climate change.</p> <p>Utilize indigenous methods for mitigating human impact on the environment.</p>
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<p>Indian”.</p> <p>ESSENTIAL UNDERSTANDING 5 History told from the Oceti Sakowin perspective, through oral tradition and written accounts, frequently conflicts with the stories mainstream historians tell and becomes subjective information. Currently historical perspective is being revisited to be more inclusive.</p> <p><b>American Indian Science Standards</b> <i>CS.A Science as Inquiry</i> American Indian peoples in the past and the present use inquiry skills to investigate and explain natural phenomena (acute observation, formulation of hypotheses, classification, measurement and communication).</p> <p><i>CS.E Science and Technology</i> Proposing a hypothetical science and technology solutions for problems is inherent in the development of traditional American Indian technologies such as used in agriculture, arts, architecture and astronomy.</p>	<p>Evaluate the impact of energy policy and the extraction of resources on tribal land and peoples (Key Stone Pipeline in South Dakota, Uranium mining on tribal land, treat rights and conflicts).</p> <p>Read and discuss excerpts from D. Wildcat’s book “Red Alert”.</p>
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<b>INDICATOR #AES 2: Understand the types of major energy systems</b>
<b>SUB-INDICATOR 2.1 (Webb Level: 3 Strategic Thinking):</b> Analyze the characteristics of wind energy generation systems
<b>SUB-INDICATOR 2.2 (Webb Level: 4 Extended Thinking):</b> Analyze the characteristics biomass energy generation systems
<b>SUB-INDICATOR 2.3 (Webb Level: 4 Extended Thinking):</b> Analyze the characteristics of solar energy generation systems
<b>SUB-INDICATOR 2.4 (Webb Level: 4 Extended Thinking):</b> Analyze the characteristics of geothermal energy generation systems
<b>SUB-INDICATOR 2.5 (Webb Level: 2 Skill/Concept):</b> Analyze the characteristics of traditional energy generation systems
<b>SUB-INDICATOR 2.6 (Webb Level: 4 Extended Thinking):</b> Model an alternative

energy system.		
<b>Knowledge (Factual):</b>	<b>Understand (Conceptual):</b>	<b>Skills (Application):</b>
<p>Knowing different types of energy sources particularly, wind, biomass, solar, geothermal, and traditional energy systems</p> <p>Advantages and disadvantage of different types of energy system</p>	<p>Different types of energy systems exist</p> <p>Know that each energy systems has their own characteristics</p> <p>Understand that model can be created for different types of energy system</p>	<p>Define and understand the different types of energy systems and their function</p> <p>Know advantages and disadvantages of the different types of energy systems</p>
<p><b>Benchmarks:</b> <i>Students will be assessed on their ability to:</i></p> <ul style="list-style-type: none"> <li>• Identify various types of wind energy systems</li> <li>• Analyze structures in wind energy systems</li> <li>• State that wind energy can be used to generate electricity</li> <li>• Identify the various types of biomass systems</li> <li>• Identify types of biomass</li> <li>• Analyze various processes used to convert biomass into energy</li> <li>• State that solar energy can be used to generate the electricity</li> <li>• State the energy conversion taking place in solar panels</li> <li>• Analyze the environmental benefits for using solar energy systems</li> <li>• Identify the various types of geothermal systems</li> <li>• Compare the advantages and disadvantages of using geothermal energy</li> <li>• Analyze the various processes used to convert geothermal into energy</li> <li>• Identify the processes involved when using nuclear energy to generate electricity</li> <li>• Identify the processes involved when using hydroelectric approaches to generate electricity</li> <li>• State the environmental benefits for using traditional energy system</li> </ul>		
<b>Academic Connections</b>		
<b>ELA Literacy and/or Math Standard (if applicable, Science and/or Social Studies Standard):</b>	<b>Sample Performance Task Aligned to the Academic Standard(s):</b>	
<p><b>Science and Engineering Practices</b></p> <ul style="list-style-type: none"> <li>• Asking Questions and Defining</li> </ul>	<p><b>Science and Engineering Practices</b></p> <p>Carry out investigations of different</p>	

<ul style="list-style-type: none"> <li>• Problems Developing and Using Models</li> <li>• Planning and Carrying out Investigations</li> <li>• Analyzing and Interpreting Data</li> <li>• Using Mathematical and Computational Thinking</li> <li>• Constructing Explanations and Designing Solutions</li> <li>• Obtaining, Evaluating, and Communicating Information</li> <li>• Engaging in Argument from Evidence</li> </ul> <p><b>Science</b></p> <p>HS-PS1-8 Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. (SEP: 2; DCI: PS1.C; CCC: Energy/Matter)</p> <p>HS-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. (SEP: 6; DCI: PS3.A, PS3.D, ETS1.A; CCC: Energy/Matter, Technology)</p> <p>HS-PS4-5 5 Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.* (SEP: 8; DCI: PS3.D, PS4.A, PS4.B, PS4.C; CCC: Cause/Effect, Technology)</p> <p>HS-LS2-3 Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.</p>	<p>energy sources including the production of biodiesel, building small wind generators, or solar cells that utilize blue berry juice to name a few.</p> <p>Research specific energy sources and develop a report to give to the class as part of a mock hearing.</p> <p>Create a brochure about the energy source or a website.</p> <p>Make an infographic about a particular source of energy, emphasizing the scientific concepts that explain how energy is transformed or transferred, environmental costs/benefits, etc.</p> <p>Create a model to demonstrate the transfer of energy from a chemical system to electrical using batteries or solar cells made with titanium dioxide and blue berry juice (photopigment molecules release electrons, see resource below).</p> <p>Create a venn diagram comparing nuclear fission and fusion.</p> <p>Play a half life game using m &amp; ms or other items to demonstrate theoretical/actual decay.</p> <p>Relate the transformation of energy in chemical reactions such as the burning of biomass, the solar cell, or a fuel cell to energy associated with the motion of particles and their relative positions.</p> <p>Create a device that converts energy from one form to another. Analyze the efficiency, the inputs and outputs and</p>
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(SEP:6; DCI: LS2.B; CCC: Energy/Matter )	<p>potential risk, benefits and costs associated with that energy conversion.</p> <p>Assess the inputs and outputs of energy in a system paying particular attention to the formation and movement of heat or infrared energy. Evaluate different energy sources and calculate the heat output. Compare these to the burning of fossil fuels and the mitigation of climate change.</p> <p>Apply the concept of waves particularly electromagnetic waves to understanding the role of light energy in the production of biomass as well as solar power and climate regulation on the planet.</p> <p>Explain and investigate how wavelength is a factor in the trapping of heat by green house gases.</p> <p>Built a photo cell and communicate how photosynthesis transforms light energy into chemical energy (release of electrons and production of NADH and ATP). Focus on the utilization of pigment molecules in solar energy and what aspect of photosynthesis is being applied.</p> <p>Relate the concept of cellular respiration to the production of biofuels and fuel cells powered by organisms.</p> <p>Build a bacterial fuel cell and investigation respiration in that system. Create biofuels utilizing bacteria and yeast. Design experiments to investigate different variables that impact the organism's ability to carry out metabolism and/or produce biofuels as</p>
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<p><b>English Language Arts</b> 9-10.RI.1 Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.</p> <p>11-12.W.1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. a. Introduce precise,</p> <p>11-12.W.2. Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.</p> <p>11-12.W.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding</p>	<p>a byproduct. Compare anaerobic/aerobic conditions.</p> <p>Create graphs that depict data regarding the movement of energy produced by alternative sources compared to conventional methods (fossil fuel vs solar).</p> <p>Design a mathematical representation of the cycling of carbon on Earth and the relative amounts of CO<sub>2</sub> in the atmosphere compared to temperature over the last 150 years.</p> <p><b>English Language Arts</b> Write and discuss abstracts from peer reviewed sources.</p> <p>Jigsaw text about alternative energy sources. Write summaries based on the information gleaned from the reading.</p> <p>Write explanations for observed phenomena and provide justification for the explanations based on scientific reasoning and data.</p> <p>Develop reports or presentations about alternative energy sources.</p>
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plagiarism and over-reliance on any one source and following a standard format for citations.

**INDICATOR #AES 3: Research alternative energy careers and trends in energy development**

**SUB-INDICATOR 3.1 (Webb Level: 3 Strategic Thinking):** Identify careers in alternative energy.

**SUB-INDICATOR 3.2 (Webb Level: 1 Recall):** Identify future energy resources.

**Knowledge (Factual):**

Career exploration in alternative energy system

Explore new energy sources for example Hydrokinetic energy

**Understand (Conceptual):**

Multiple career opportunities exist in the alternative energy system and need to be explored

Investigating newer energy systems to meet the growing energy demand

**Skills (Application):**

Be able to identify the different career options in alternative energy systems

Explore the avenues to identify the newer sources of energy

**Benchmarks**

*Students will be assessed on their ability to:*

- Investigate jobs in each of the alternative energy fields
- Research, create a report, and present your findings on a career of interest in alternative energy
- Identify new fields of study such as Marine Hydrokinetic Energy

**Academic Connections**

**ELA Literacy and/or Math Standard (if applicable, Science and/or Social Studies Standard):**

**English Language Arts**

9-10.RI.1 Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

**Sample Performance Task Aligned to the Academic Standard(s):**

**English Language Arts**

Research different careers in Alternative energy fields. Create a brochure or a presentation about that career. Highlight educational requirements, skill sets, typical activities, salaries and where

<p>11-12.W.1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. a. Introduce precise,</p> <p>11-12.W.2. Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.</p> <p>CC.11-12.W.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.</p> <p>11-12.W.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and over-reliance on any one source and following a standard format for citations.</p> <p><b>Oceti Sakowin</b> ESSENTIAL UNDERSTANDING 2 There is variety and resiliency among individual Tribal people as identity is developed, defined and redefined by entities, organization and people. A continuum of</p>	<p>these jobs as well as the education for these jobs is located.</p> <p>Research and write a report about future energy sources or emerging research in energy production such as the use of extremophiles for enzymatic efficacy in the production of ethanol.</p> <p>Write a cover letter and create a CV for a particular job in an alternative energy field.</p> <p>Create a mock Facebook profile or Linked In profile for someone who works with alternative energy.</p> <p>Research trends in energy careers, boom/bust patterns such as what happened in North Dakota and Wyoming. Debate the pros and cons of the extraction of these resources or use of these energy sources. Write a short story, play or song that explains those trends.</p> <p><b>Oceti Sakowin</b> Research emerging alternative energy careers and projects in tribal communities.</p> <p>Evaluate different energy sources from a Lakota lens. Does the source align with Lakota values? Write a paper discussing</p>
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<p>tribal identity, unique to each individual, ranges from assimilated to traditional lifestyle. There is no “generic American Indian”.</p> <p>ESSENTIAL UNDERSTANDING 5 History told from the Oceti Sakowin perspective, through oral tradition and written accounts, frequently conflicts with the stories mainstream historians tell and becomes subjective information. Currently historical perspective is being revisited to be more inclusive.</p>	<p>the impact of energy production on tribal communities and issues tribes face.</p> <p>Use case studies (see below)</p>
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### **Additional Resources**

Please list any resources (e.g., websites, teaching guides, etc.) that would help teachers as they plan to teach these new standards.

Disciplinary Core Ideas for Science Education

<http://doe.sd.gov/contentstandards/documents/ApxA-DCIP.pdf>

Science and Engineering Practices and Cross Cutting Concepts

<http://doe.sd.gov/contentstandards/documents/ApxB-SEPC.pdf>

Engineering Design Standards

<http://doe.sd.gov/contentstandards/documents/ApxCengin.pdf>

American Indian Case Studies and Energy Issues

<http://nativecases.evergreen.edu/collection/themes/energy.html>

Blueberry Electricity: An Experimental Introduction and Analysis of Fruit and Chlorophyll based Dye-Sensitized Solar Cells

<http://solar.org.au/papers/07papers/Paper41.pdf>

Artificial Photosynthesis and Dye Sensitized Solar Cells

<https://drive.google.com/a/k12.sd.us/file/d/0B80QQKRfWQc7YjJ0SXB20W9lSmM/view?usp=sharing>

NASA Climate Change Resources



<http://climate.nasa.gov/>

Historic Climate Data South Dakota

[http://climate.sdstate.edu/coop/monthly.asp?stationz=392207&Submit=Get+Data  
&from month=1&from year=1877&to month=1&to year=1877](http://climate.sdstate.edu/coop/monthly.asp?stationz=392207&Submit=Get+Data&from%20month=1&from%20year=1877&to%20month=1&to%20year=1877)

US Forest Service Tree Atlas and modeling for climate change

<http://www.fs.fed.us/nrs/atlas/tree/316>

Climate Change Fact Sheet South Dakota

[https://www.whitehouse.gov/sites/default/files/docs/state-  
reports/SOUTHDAKOTA\\_NCA\\_2014.pdf](https://www.whitehouse.gov/sites/default/files/docs/state-reports/SOUTHDAKOTA_NCA_2014.pdf)

Half Life Activities for teaching nuclear fission and decay

[http://www.nuclearconnect.org/wp-content/uploads/2014/06/Half Life ALL.pdf](http://www.nuclearconnect.org/wp-content/uploads/2014/06/Half_Life_ALL.pdf)